Part II
5. WELDING

5.1 Specifications

5.1.1 Welding Material

All electrodes, fluxes and shielding gases should conform to the latest American Welding Society (AWS) A5-series specifications.

The Contract Documents should specify the appropriate AWS specifications for welding material to be used. Any special requirements, including identification of the joints of the steel frame subjected to such requirements, must be clearly defined in the Contract Documents. Such requirements may include control of CVN toughness, diffusible hydrogen levels, and additional manufacturer or contractor testing. Where specified CVN toughness for filler metal is required for designated joints, the minimum CVN toughness value(s), testing temperature(s), and special testing parameters if required, shall be specified.

5.1.2 Weld Acceptance Criteria

The Contract Documents should establish the level of welding quality required for the project. Quality requirements for members of the seismic-force-resisting system may be different from the requirements for other members. Such criteria may be those established in *AWS D1.1*, or other suitable criteria as suggested in the technical literature. The use of acceptance criteria other than that prescribed in *AWS D1.1* is permitted by *AWS D1.1*, Section 6.8.

Welds executed by welding personnel who do not satisfy the personnel performance qualifications, and welds not executed in conformance with the approved Welding Procedure Specification (WPS), may be considered rejectable and require evaluation by a qualified Engineer or welding consultant.

5.2 Submittals

5.2.1 Welding Material

The Contract Documents should require the submittal of certifications for all welding material, including electrodes, fluxes and shielding gases. The manufacturer's certification should state that the welding electrodes, fluxes and shielding gases, as supplied, meet the applicable AWS A5 specifications. The manufacturer's data sheets for the welding materials should also be submitted. A copy should be provided to the appropriate Inspectors for review.

> *Commentary: Manufacturer's certifications are for compliance with the appropriate AWS A5 Specification, and are not a material test report taken from the specific lot of material being used. Such lot-specific tests are not required.*

5.2.1.1 Supplemental CVN Toughness Verification Tests

The Contract Documents should require the submittal of results of specified tests conducted to verify the CVN toughness achieved using the filler metal selected for joints with special toughness requirements. The test protocol should follow that specified in Part I of these *Recommendations* for such purpose. Tests may be conducted by the filler metal manufacturer, contractor, or by a third party laboratory or agency. Testing by production lot is required unless a manufacturer testing and certification program acceptable to the Engineer is in use for the filler metal.

5.2.2 Welding Procedure Specifications

The Contract Documents should require the submittal of Welding Procedure Specifications (WPSs) for each weld to be made on the project. For shop welds, the Fabricator is responsible for developing and supplying the WPSs. For field welds, the Erector is responsible for developing and supplying the WPSs. The WPSs may also be developed and prepared by other competent sources, but remain the responsibility of the Fabricator or Erector.

Procedure Qualification Records (PQRs) shall be supplied for all non-prequalified WPSs.

The Contract Documents should require submittal of the WPSs to the Engineer for review. The WPSs should also be distributed to the Inspectors responsible for welding inspection.

The Engineer should review the WPSs for general suitability and adequacy, but need not take responsibility for the suitability or quality of the welds made using such procedures. Such responsibility remains with the Contractor responsible for the welding.

> *Commentary: WPSs, as with other Contractor-developed documents such as shop drawings, erection drawings and product data, should be reviewed by the Engineer to confirm conformance with the Contract Documents and design intent. Historically, Engineers and other design professionals routinely reviewed and approved Contractor submittals and recent editions of AISC and AWS specifications and codes have required that the Engineer approve such submittals. For example:*
>
> - *AISC Seismic Provisions for Structural Steel Buildings, Section 7.3a states:*
>
> *"Welding shall be performed in accordance with a Welding Procedure Specification (WPS) as required in AWS D1.1 and approved by the Engineer of Record."*
>
> - *AWS D1.1, Section 6.3.1 (1998 edition) states:*
>
> *"The Inspector shall verify that all WPSs have been approved by the Engineer in accordance with 4.1.1."*

- *AWS D1.1, Section 4.1.1 states:*

  "Except for prequalified WPSs, a WPS for use in production welding shall be qualified … and approved by the Engineer."

However, over the past 20 years, there has been an evolution in design practice with design professionals refusing to approve submittals, and instead, reviewing submittals for general conformance and either taking exception or not. The 2000 edition of AWS D1.1 acknowledges this changing practice and in Section 6.3.1, replacing the earlier Section 6.3.1, states:

"The Inspector shall review all WPSs to be used in the work and shall make certain that the procedures conform to the requirements of this code."

This revision is not intended to preclude critical Contractor submittals, such as WPSs to the design professional, but rather is intended to acknowledge that the Engineer's review of such submittals does not constitute an approval.

5.2.3 Other Submittals

The Contractor should maintain at the jobsite and make available to the Engineer, Inspector and NDT Technician all drawings, project specifications, material certifications, welder qualification records, WPSs and PQRs applicable to the project.

Commentary: As used in this section, jobsite applies both to the fabrication shop while fabrication work is being performed, and the construction site during erection.

5.3 Material Control

Identification of welding material should be maintained. Control should be exercised to verify that welding material with adequate notch toughness is used. Special welding material control requirements such as lot traceability are not required for standard welding material. Lot control may be advisable for welding material with special notch toughness requirements, should significant variations between lots, as established by tests, result in samples failing to achieve the required toughness.

Commentary: Manufacturer certifications document the overall quality of all welding material supplied, and variation from lot to lot is generally not significant.

5.3.1 Storage

The Contract Documents should specify special storage or material control requirements, if necessary. Welding material storage controls, such as requiring rod storage ovens and having limited atmospheric exposure times for SMAW low-hydrogen electrodes, must be as prescribed

in *AWS D1.1*, Section 5. Supplemental storage requirements for FCAW electrodes may be advisable for certain conditions and electrodes as well.

5.4 Quality Control and Quality Assurance

The Quality Assurance Plan should contain a list of all welding inspections required and designate the party responsible for each task. Inspections may be provided by the Contractor (the Fabricator or the Erector), by the Special Inspector, by the Welding Inspector, or by the Nondestructive Testing Technician.

The Contract Documents should specify the type and location of any joints requiring NDT other than visual. The extent of NDT, whether full length, partial length, or spot testing should be clearly stated. See *AWS D1.1*, Section 6.15.

In the series of design criteria and specification documents developed under this project, Quality Control and Quality Assurance tasks are recommended depending on the severity of loading (Seismic Weld Demand Categories) on a weld and the consequences of adverse welded joint performance (Seismic Weld Consequence Categories). Figure 5-1 provides a recommended checklist for prefabrication inspection for welding, applicable to all elements of the seismic force resisting system. Table 5-1 defines three Seismic Weld Demand Categories and provides guidance as to which welded joints should be assigned to each category. Table 5-2 defines three Seismic Weld Consequence Categories and provides guidance as to which consequence category various welded joints should be assigned. Table 5-3 assigns each type of welded joint to a Process and Visual Inspection class, depending on the Seismic Weld Demand Category and Seismic Weld Consequence Category for the joint. Table 5-4 provides recommendations for Nondestructive Testing for each class of welded joint. Table 5-5 is a checklist summarizing all recommendations for process and visual inspection for the various classes.

Commentary: The basic code requirements for structural welding of steel structures are contained in AWS D1.1 - Structural Welding Code - Steel. AWS D1.1 uses the term "Fabrication/Erection Inspection" synonymously with the "Quality Control" function. The term "Verification Inspection" is used to describe the "Quality Assurance" function. AWS D1.1 requires inspection for many items in Section 6, Part A, but does not specify whether the inspection is performed as either QC or QA. Such distinction must be provided in the Contract Documents.

In these Recommendations, the extent of inspection and other Quality Control and Quality Assurance measures recommended for a specific joint is dependent on the severity of joint loading or demand and the consequences of adverse joint performance. FEMA-350 – Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings, FEMA-351 – Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings and FEMA-352 – Postearthquake Evaluation and Repair Criteria for Steel Welded Moment-Frame Buildings, indicate the required quality control and quality assurance

classes for welded joints in steel moment frames, using prequalified connections. The criteria shown in the Tables 5-1 through 5-3 may be used to select appropriate inspection classes for joints that are not prequalified under these companion publications.

5.5 Quality Control Tasks

5.5.1 Welding Quality Control Program

The Contractor's QC program for welding should, as a minimum, include:

- Welders must be qualified for the work in accordance with *AWS D1.1*, Section 4, Parts A and C.
- Welding personnel should be knowledgeable regarding the use of Welding Procedure Specifications (WPSs), basic workmanship provisions, and in the use of weld gages and temperature measurement devices such as temperature indicating crayons.
- Suitable WPSs must be provided for all welding to be performed, and must be available to welding personnel at the place of work.
- Welding equipment must be adequate and functioning properly, and calibrated for accuracy within the past year.
- Welding material storage equipment such as rod ovens and flux ovens must be available and functional, if required by the process, the filler metal or the flux.
- Welding inspectors must be qualified in accordance with *AWS D1.1,* Section 6.1.4 to perform QC inspection.
- If not provided by the Contractor's QC personnel, outside NDT services must be available to the Contractor on an as-needed basis.

Table 5-5 provides recommendations for QC in-process inspections for a variety of welded joint classifications.

Commentary: The Contractor should require and ensure that welders meet established minimum requirements. Execution of critical welds requires skilled welders who will follow the project welding requirements.

5.6 Extent of Welding Inspection and Nondestructive Testing

The Quality Assurance Plan, the information furnished for bidding, and the Contract Documents should clearly identify the extent of inspection and Nondestructive Testing (NDT) to be performed by the Contractor and by the Quality Assurance Agency's Inspector or NDT Technician. Any approved periodic inspection should clearly be identified by type and frequency. Weld joints for which the Contract Documents require NDT should be tested for their full length, unless partial or spot testing is specified. When partial or spot testing is specified, the location and lengths of welds or categories of weld to be tested should be clearly designated in the

Contract Documents, or identified using NDT symbols in conjunction with the welding symbols on the design drawings. See *AWS D1.1,* Section 6.15.

Tables 5-1, 5-2, 5-3, 5-4, and 5-5 provide recommendations for the classification of welded joints, NDT requirements and in-process welding inspection requirements. Refer also to the Quality Control and Quality Assurance requirements specified in *FEMA-350*, *FEMA-351* and *FEMA-352* for prequalified moment-resisting connections.

On projects where a sliding sampling scale is used, the Inspector should keep records on each welder or welding operator. These records may be used as a basis for sampling rate reduction.

Commentary: See Notes to Table 5-4 for an illustration of a sampling scale method for UT inspection.

5.7 Welding Inspector Tasks

The duties of the Welding Inspector, whether designated as QC or QA, should include the following items.

a. Review and understand the applicable portions of the specifications, the Contract Documents and the shop drawings for the project.

b. Review material test reports for all main member and designated connection base material for compliance with the project requirements, prior to shop fabrication.

c. Verify that all applicable welder, welding operator and tack welder qualifications are available, current and accurate.

d. Require requalification of any welder, welding operator or tack welder who has, for a period of six months, not used the process for which the welder was qualified.

e. Verify welder identification and qualification. Verify that any required supplemental qualification tests have been passed, and joint mock-ups, if required by the Contract Documents, have been executed.

f. Verify that each welder has a unique identification mark or die stamp to identify his or her welds.

g. Verify that all applicable Welding Procedure Specifications, with Procedure Qualification records as needed, are available and current.

h. Verify that an approved Welding Procedure Specification (WPS) has been provided and that each welder performing the weld has reviewed the WPS. A copy of the appropriate WPSs should be available for each joint.

i. Verify base material identification checks against approved shop drawings and specifications.

j. Verify the electrode, flux and shielding gas specification sheets for compliance with the Contract Documents.

k. Verify welding consumables comply with approved shop drawings and the approved WPSs.

l. Verify that electrodes are used only in the permitted positions and within the welding parameters specified in the WPS.

m. At suitable intervals, observe joint preparation, assembly practice, preheat temperatures, interpass temperatures, welding techniques, welder performance and any postweld heat treatment to ensure that the applicable requirements of the WPS and Code are satisfied.

n. At suitable intervals, verify that the current and voltage of the welding equipment are in accordance with the WPS, if needed, by using a hand-held, calibrated, amp and volt meter. With this equipment, current and voltage should be measured near the arc.

o. Inspect the work to ensure compliance with AWS D1.1 or the specified weld acceptance criteria. Size and contour of welds should be measured with suitable gauges. A strong light, magnifiers, or other devices, as needed, may be used to aid visual inspection.

p. Schedule NDT technicians in a timely manner, after the visual inspection is complete and the assembly has cooled. A delay period may be required by the Contract Documents for final QA acceptance. For repair welding, the Nondestructive Testing should not be performed sooner than 24 hours after the repair welding has been completed and cooled to ambient temperature.

q. Mark those welds, parts, and joints, that have been inspected and accepted, with a distinguishing mark or die stamp, or alternatively, maintain records indicating the specific welds inspected by each person.

r. Document the accepted and rejected items in a written report. The report should be transmitted to the designated recipients in a timely manner.

Table 5-5 may be used as a guide for in-process welding inspection tasks. The sample checklists and forms in Figure 5-1 and Tables 5-1 through 5-5 are provided to assist in the development, understanding, and reporting of welding inspection tasks.

5.8 NDT Technician Tasks

The NDT technician should coordinate the NDT work with the Welding Inspector. The NDT technician must perform all NDT, other than visual, required by the Quality Assurance Plan, Contract Documents or Building Code. NDT should be performed in a timely manner, so as not to hinder production, and to detect welding problems soon after occurrence so that corrective measures may be taken by the Contractor to rectify such problems.

The NDT technician should mark those welds, parts, and joints, which have been inspected and accepted, with a distinguishing mark or die stamp, or alternatively, maintain records indicating the specific welds inspected.

The accepted and rejected items should be documented in a written report. The report should be transmitted to the designated recipients in a timely manner.

Checklist for Prefabrication Inspection for Welding

Project _____

Fabricator/Erector _____

Welding Systems Verification

- ❑ Welding personnel qualification records available
- ❑ Audit of welding personnel performed Date____/____/____ By _____
- ❑ List of needed WPSs prepared for project
- ❑ WPSs for project complete
- ❑ WPSs reviewed and approved by Engineer Date____/____/____ By _____
- ❑ WPSs available to welding personnel
- ❑ WPSs available to QC/QA personnel
  (Note: prepare separate WPS log if needed)
- ❑ Welding equipment calibration records available
- ❑ Audit of welding equipment operation performed Date____/____/____ By _____
- ❑ Filler metal storage systems in place
- ❑ Filler metal storage systems followed
- ❑ SMAW electrode ovens
  - ❑ Temperature verified
  - ❑ Continuous operation verified
- ❑ SAW flux ovens
  - ❑ Temperature verified
  - ❑ Continuous operation verified
- ❑ FCAW wires suitably protected
- ❑ GMAW wires suitably protected
- ❑ SAW wires suitably protected

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Figure 5-1 Checklist for Prefabrication Inspection for Welding

Checklist for Prefabrication Inspection for Welding

Project Material Verification (Welding)

Welding Electrodes

Process (SMAW, FCAW, GMAW, SAW)				
Electrode class (A5 designation)				
Manufacturer				
Trade name				
Diameter				
Packaging type (for example, can, box, oven)				
Packaging condition (good, damaged, open)				
Certification papers available (yes, no)				
Certification papers reviewed (date)				

Shielding Gas

Supplier				
Type (for example, CO_2)				
Certification papers available (yes, no)				
Certification papers reviewed (date)				

SAW Flux

Manufacturer				
Trade Name				
Type (active, neutral, alloy)				
Packaging type (for example, bag, oven)				
Packaging condition (good, damaged, open)				
Certification papers available (yes, no)				
Certification papers reviewed (date)				

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Figure 5-1 Checklist for Prefabrication Inspection for Welding (continued)

Table 5-1 Seismic Weld Demand Categories

Demand		Examples
A **High**	Welds in which service stresses are anticipated to be at or beyond the yield level, with some inelastic strain demand into the strain hardening region anticipated.	Beam-flange-to-column-flange CJP groove welds in: • unreinforced connections, • RBS connections, with "weak" panel zones, • free-flange connections.
B **Medium**	Welds in which service stresses are anticipated to be near or slightly exceed yield level, but for which negligible inelastic strain demand is anticipated.	Beam-flange-to-column-flange CJP groove welds in: • RBS connections with "strong" panel zones, • haunched connections, • cover-plated connections, • "Overlay" connections. In haunched connections, haunch-to-beam-flange and haunch-flange-to-column-flange CJP groove welds. Fillet welds in cover-plated and haunched connections. Web welds (shear tab or direct welded) in all moment connections. Doubler plate and continuity plate welds (both groove and fillet welds). CJP and PJP groove welded splices in butt joints with applied tension. In braced frames, all CJP and PJP groove welds between brace and beam or column (but not including gusset plates).
C **Low**	Welds in which service stresses are anticipated to remain below stresses permitted for design, or will remain in compression. Note: For LRFD, permitted design stress is defined as using $(fF_w$ as $0.80(0.6F_{EXX})$) or lower as the design strength. For ASD, permitted design stress is defined as using an allowable stress of $0.3F_{EXX}$.	All other CJP and PJP groove welds in shear or compression, or a combination of shear and compression. All other fillet welds. All plug and slot welds.

Table 5-2 Seismic Weld Consequence Categories

H **High**	Steel moment frames with low redundancy (4 or fewer beams per floor resisting lateral forces in principal direction). Any shear joint supporting gravity loads from two or more floors. Splices resisting applied tension.
M **Medium**	Joints in steel moment frames, with redundancy. Joints in steel moment frames with a designed secondary system for lateral loading. Any shear joint supporting gravity loads from more than one member at a given floor level. Splices resisting only shear or compression or both.
L **Low**	Shear, compression and tension joints supporting single members only, and not part of the lateral-force-resisting system. Joints not required to carry gravity loads.

Table 5-3 Process and Visual Inspection Categories

Consequence	**Demand**		
	A	**B**	**C**
H	1	1	2
M	1	2	3
L	2	3	3

Note: Refer to Table 5-5 Welding Inspection Checklist

Table 5-4 Nondestructive Testing

Consequence	Demand		
	A	**B**	**C**
H	**CJP** MT 100% of joints, full length UT 100% of joints, full length **PJP, fillets** MT 100% of joints full length	**CJP** MT 100% of joints, full length if transversely loaded, partial length if longitudinally loaded UT 100% of joints, full length if transversely loaded, partial length if longitudinally loaded (Reduce UT to 25% of joints, of length as above, with high acceptance rate) **PJP, fillets** MT 25% of joints, full length if transversely loaded, partial length if longitudinally loaded	**CJP** UT 10% of joints, full length if transversely loaded, partial length if longitudinally loaded **PJP, fillets** MT 10% of joints, 6" spot at random
M	**CJP** MT 100% of joints, full length UT 100% of joints, full length (Reduce UT to 25% of joints, full length, with high acceptance rate) **PJP, fillets** MT 100% of joints full length	**CJP** MT 100% of joints, full length if transversely loaded, partial length if longitudinally loaded UT 100% of joints, full length if transversely loaded, partial length if longitudinally loaded (Reduce UT to 25% of joints, of length as above, with high acceptance rate) **PJP, fillets** MT 25% of joints, full length if transversely loaded, partial length if longitudinally loaded	No NDT required
L	**CJP** MT 25% of joints, full length. UT 25% of joints, full length **PJP, fillets** MT 100% of joints full length	**CJP** UT 10% of joints, full length **PJP, fillets** MT 10% of joints, 6" spot at random	No NDT required

Notes:
1. CJP, complete joint penetration; PJP, partial joint penetration; MT, magnetic particle testing; UT, ultrasonic testing.
2. UT only when weld throat is 5/16" or greater.
3. Reduce rate of UT and MT when an individual welder's reject rate is less than 5%, after 40 welds have been inspected.
4. Partial length testing for longitudinally loaded welds is applicable for welds over 24" in length, and includes the beginning and end of each weld for a 6" length, plus any location along the length of the weld where a start and restart is visually noted for a distance of 6" on either side of the stop/start location, and a 6" length every 10' for a given weld.
5. CJP and PJP groove welded column splices that are a part of the seismic-force-resisting system and are subject to applied tension shall be ultrasonically tested as BH/T

Table 5-5 Welding Inspection Checklist

Process and Visual Welding Inspection Category		1				2				3			
Inspection Tasks	Welder	QC		QA		QC		QA		QC		QA	
		H	O	H	O	H	O	H	O	H	O	H	O
Inspection Prior To Welding													
Proper WPS selected for joint detail	✓	✓		✓		✓			✓		✓		✓
Proper welding materials selected	✓	✓		✓		✓			✓		✓		✓
WPS settings (voltage, polarity, current, wire feed speed) on welding equipment verified	✓	✓			✓✓		✓		✓		✓		✓
Shielding gas type (if used) verified	✓	✓			✓		✓		✓		✓		✓
Shielding gas flow rate setting verified	✓	✓			✓		✓		✓		✓		✓
Fit of backing bar (if used) acceptable	✓	✓			✓		✓		✓		✓		✓
Measure root opening	✓		✓		✓		✓		✓		✓		✓
Measure groove angle	✓		✓		✓		✓		✓		✓		✓
Verify above dimensions within joint tolerance and WPS tolerance	✓	✓			✓		✓		✓		✓		✓
Mark root edge location on beam flange for UT inspection (if required)	✓	✓			✓		✓		✓		✓		✓
Condition of steel surface acceptable	✓	✓			✓		✓		✓		✓		✓
Existing tack welds clean and of adequate quality	✓	✓			✓		✓		✓		✓		✓
Wind speed within limits	✓		✓		✓		✓		✓		✓		✓
Weld joint surfaces free of discontinuities	✓		✓		✓		✓		✓		✓		✓
Minimum preheat required applied and verified	✓		✓✓		✓✓		✓		✓		✓		✓
Maximum preheat verified (if specified)	✓		✓✓		✓✓		✓		✓		✓		✓
Observation of welder's inspection	✓		✓✓		✓		✓		✓		✓		✓
Observation of QC inspection					✓✓		✓		✓				✓

See Legend and Notes at end of Table

Table 5-5 Welding Inspection Checklist (page 2)

Process and Visual Welding Inspection Category		1				2				3			
Inspection Tasks	Welder	QC		QA		QC		QA		QC		QA	
		H	O	H	O	H	O	H	O	H	O	H	O
Inspection During Welding													
WPS followed (voltage, current, wire feed speed, travel speed, stickout, gas flow rate, pass location)	✓		✓✓		✓✓		✓✓		✓		✓		✓
Welding materials exposure control maintained	✓		✓✓		✓✓		✓✓		✓		✓		✓
Minimum interpass temperature maintained and verified	✓		✓✓		✓✓		✓✓		✓		✓		✓
Maximum interpass temperature verified (if specified)	✓		✓✓		✓✓		✓✓		✓		✓		✓
No detrimental change to environmental conditions	✓		✓		✓		✓		✓		✓		✓
Tack welds do not crack during welding	✓		✓		✓		✓		✓		✓		✓
Each pass cleaned	✓		✓		✓		✓		✓		✓		✓
Each pass within profile limitations	✓		✓		✓		✓		✓		✓		✓
Each pass meets quality requirements	✓		✓		✓		✓		✓		✓		✓
Proper technique used (electrode angle, stringer beads)	✓		✓		✓		✓		✓		✓		✓
NDT in process when required	✓	✓		✓		✓		✓			✓		✓
Observation of welder's inspection			✓		✓		✓		✓		✓		✓
Observation of QC process					✓				✓				✓

See Legend and Notes at end of Table

Table 5-5 Welding Inspection Checklist (page 3)

Process and Visual Welding Inspection Category		1				2				3			
Inspection Tasks	Welder	QC		QA		QC		QA		QC		QA	
		H	O	H	O	H	O	H	O	H	O	H	O
Inspection After Welding													
Welder identification legible	✓	✓		✓		✓		✓		✓			✓
Inspection delay period satisfied		✓		✓		✓		✓		✓		✓	
Weld cleaned	✓	✓		✓		✓		✓		✓		✓	
Weld size and length verified	✓	✓			✓	✓			✓	✓			✓
Weld within profile limitations	✓	✓			✓	✓			✓	✓			✓
Weld appearance indicates thorough fusion	✓	✓		✓		✓		✓		✓			✓
Weld craters acceptable	✓	✓			✓	✓			✓	✓			✓
Undercut within limitations	✓	✓		✓		✓		✓		✓			✓
Porosity within limitations	✓	✓			✓	✓			✓	✓			✓
Weld free of cracks	✓	✓		✓		✓		✓		✓			✓
Backing bars removed (if required)	✓	✓		✓		✓		✓		✓			✓
Weld tabs removed (if required)	✓	✓		✓		✓		✓		✓			✓
Surface finish (grind, contour) as required	✓	✓		✓		✓		✓		✓			✓
Observation of welder's inspection			✓		✓	✓	✓		✓		✓		✓
Observation of QC process					✓				✓				✓
NDT completed				✓		✓		✓		✓		✓	

See Legend and Notes at end of Table

Table 5-5 Welding Inspection Checklist (page 4)

Legend:

✓	The welder or Inspector, as noted, should perform this function, with measurements as necessary.
✓✓	The Inspector should observe these operations more frequently.
H	Hold – The welder shall not proceed with welding until inspection of this item is performed by the designated Inspector. After this inspection, the welder may proceed with welding until completion, with observation of welding functions on a random, periodic basis by the Inspector. For inspection after welding, this inspection must be performed prior to final acceptance of the item.
O	Observe – The welder may proceed with welding after completing his / her own inspection. The Inspector shall perform random, daily, periodic inspection and observation of these welding functions.

Notes:

1. The precise level and frequency of observation by either QC or QA is not specified. Inspection frequency shall be adequate to provide reasonable confidence in the control of the welding process and the quality of the completed welds. Consideration shall be made of the consistency achieved in satisfying the required welding parameters, and the effect of the welding parameter upon weld quality and performance.
2. As a minimum, the observation inspection tasks listed shall be performed on a daily basis.
3. Hold point inspections for WPS selection and welding materials need be performed only when changed by the welder.
4. This list shall not be considered exclusive of any additional inspection tasks that may be necessary to meet the requirements of the codes or the Quality Assurance Plan.